



WARHØRSE



KINGDOM COME: DELIVERANCE CHARACTER CLOTHING

TOMAS BARAK

WARHORSE STUDIOS

©2015



OUTLINE

- MOTIVATION AND CHALLENGES
- LAYERING OF MORPHED MESHES
- RAY-CASTING
- CONCLUSION



MOTIVATION AND CHALLENGES



RPG GAMES

- PLAYER CAN KILL/LOOT ANYBODY
- PLAYER CAN EQUIP ANY ITEMS FOUND
 - CAN WEAR MORE ITEMS TOGETHER
- OUR RPG GAME
 - NPCs CAN DO THE SAME
 - REALISM TOGETHER WITH THE VARIETY





OUR ISSUE - COMBINATIONS



POSSIBLE APPROACHES

- SAME SHAPES / MESHES FOR ALL ITEM TYPES
- BIG (SAFE) DISTANCES BETWEEN MESHES
- HAND MADE TUNING FOR ALL COMBINATIONS
- HYBRID APPROACHES ...



OUR SOLUTION

- GOOD REALISM
- NO ADDITIONAL ARTIST INPUT PER NEW PIECE OF CLOTHING



LAYERING OF MORPHED MESHES



OUR SETUP (SIMPLIFIED)

- CLOTHING LAYERS
 - BODY, CLOTH, CHAINMAIL, PLATE, DECORATION
 - OUTER LAYERS COVER INNER LAYERS
 - INFLUENCE MATRIX



OUR SETUP (SIMPLIFIED)

- PIECES OF CLOTHING ADAPT
- MORPHED MESHES
 - GUIDE THE ADAPTION
 - STORE VARIATIONS
 - EXPRESS BODY PROPORTIONS (FAT, SLIM)
- MORPHS ARE APPLIED ONCE!



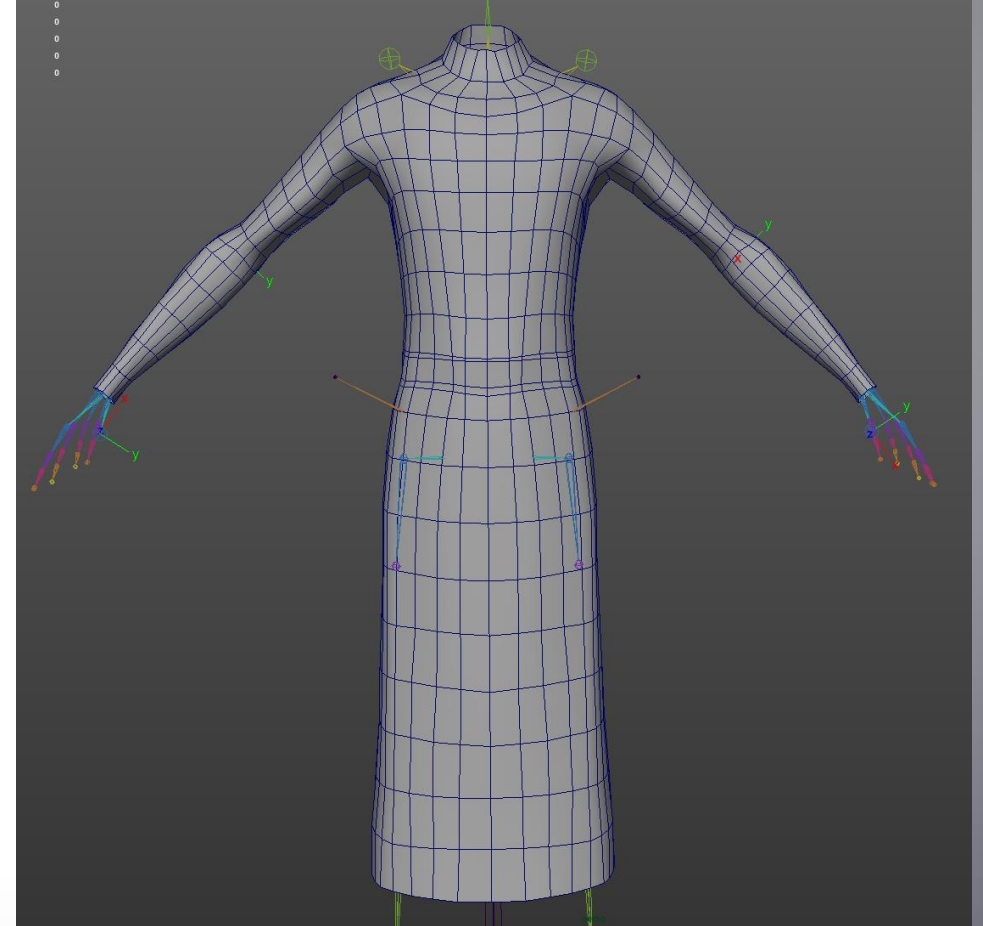
TERMINOLOGY

- BASE SHAPE
 - ITEM ALONE
 - CREATED BY ARTISTS



TERMINOLOGY

- SHRUNK SHAPE
 - MAXIMUM ADAPTATION
 - BASE + SHRINK MORPH
 - CREATED BY ARTISTS
 - *COULD* BE GENERATED



INPUT FROM ARTISTS

- BASE MESH
- SHRINK MORPH
- MATERIAL
 - TEXTURES



VARIATION MORPHS

- SAME TOPOLOGY, SIMILAR SHAPE
 - REUSE BASE MESH
 - CREATE VARIATION MORPH
 - REUSE SKINNING, UVs, TRIANGLES, NORMALS
 - SAVE DATA, SAVE TIME ☺



CLOTH LAYER (BASE + VARIATIONS)



ARMOR LAYER – MORE BASE MESHES



RAY-CASTING



LAYERING BY RAY-CAST

- INPUT: A CHARACTER WITH EQUIPPED ITEMS
 - EACH MESH IN THE BASE AND SHRUNK SHAPE



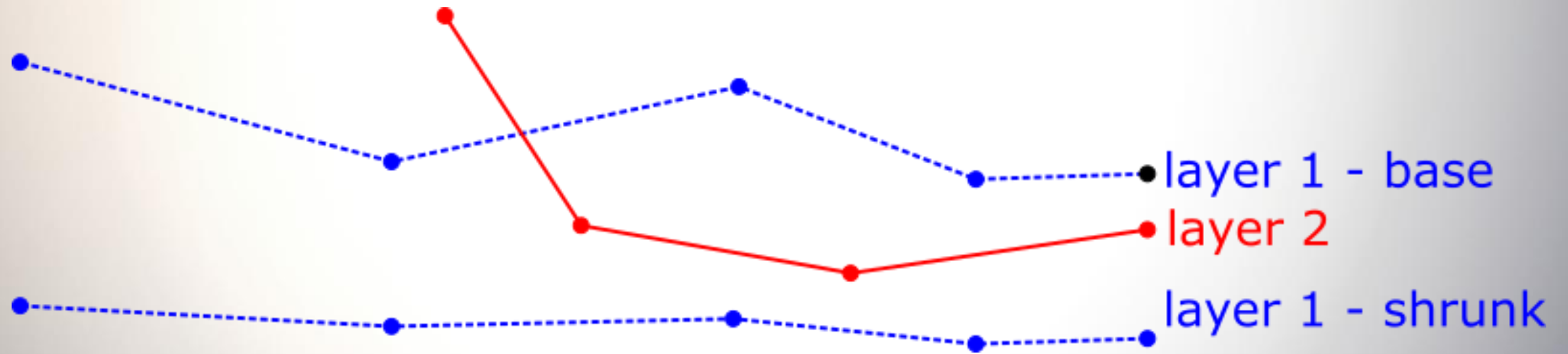
LAYERING BY RAY-CAST

- OUTPUT: FOR EACH MESH VERTEX A WEIGHT W
 - W BLENDS THE BASE AND SHRUNK SHAPE
 - $W = 1 \rightarrow$ NO ADAPTATION
 - $W = 0 \rightarrow$ MAXIMAL ADAPTATION



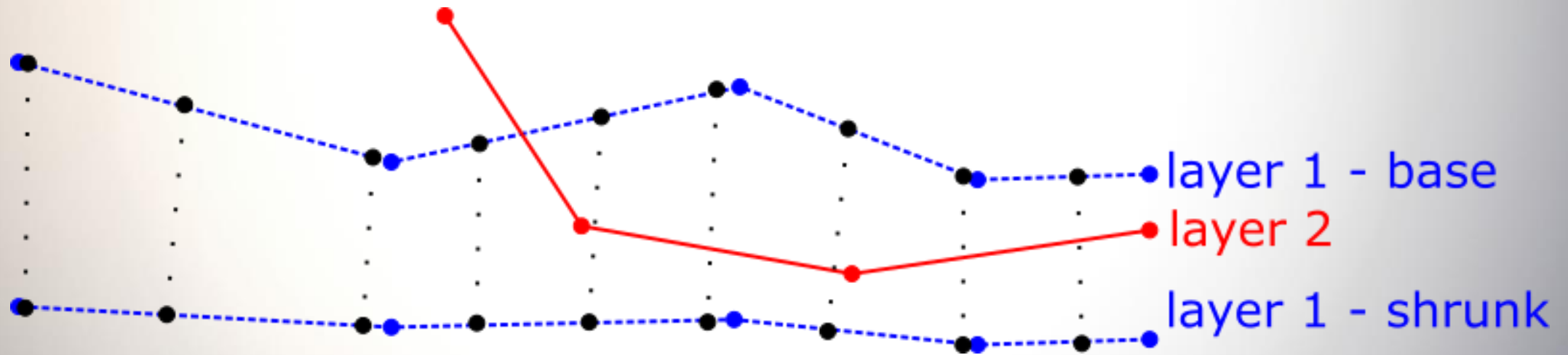
BASE ALGORITHM

- FOR EVERY PAIR OF MESHES



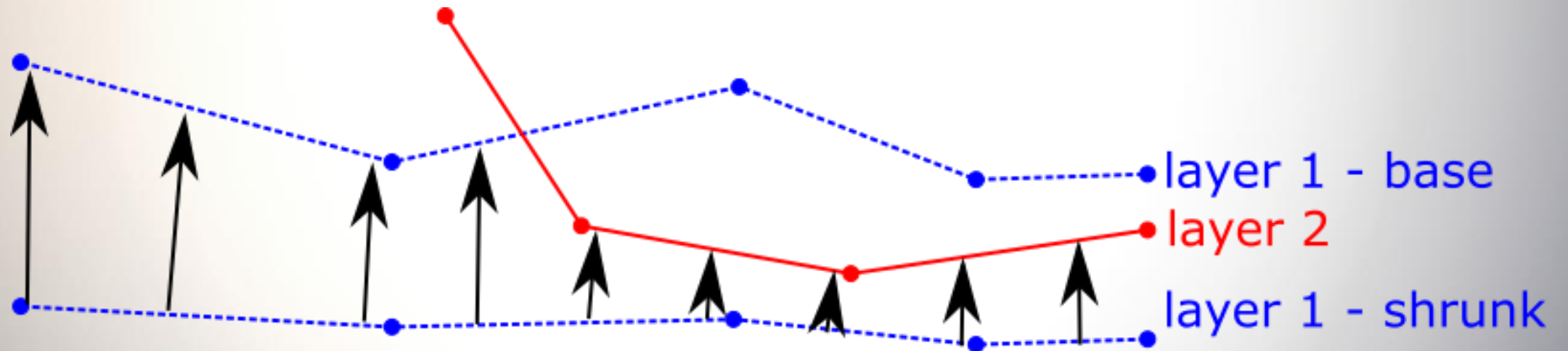
BASE ALGORITHM

- FOR EACH TRIANGLE
 - PICK N RANDOM SAMPLES (BARYCENTRIC COORDINATES)



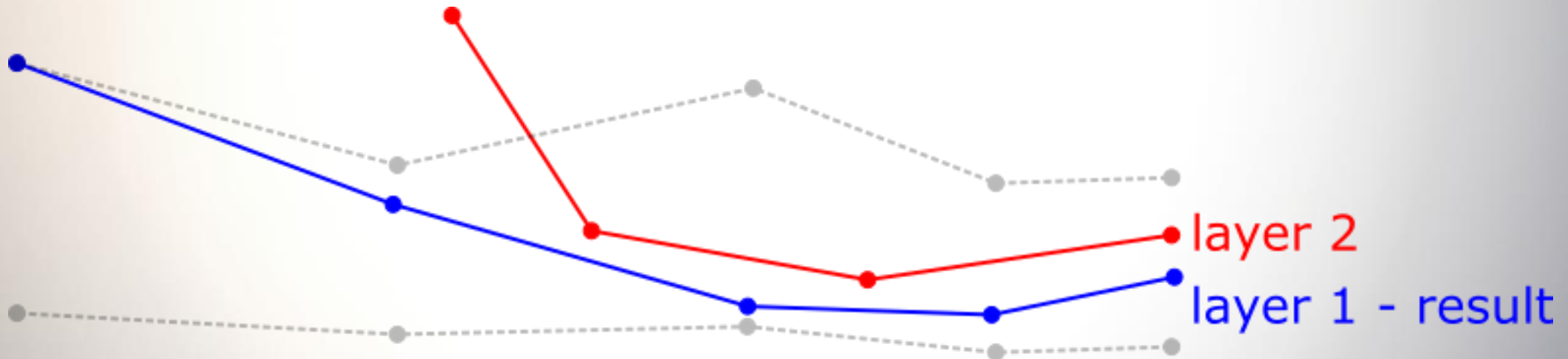
BASE ALGORITHM

- FOR EACH TRIANGLE
 - TRACE N RAYS



BASE ALGORITHM

- FOR EACH TRIANGLE
 - TRANSFORM INTERSECTIONS TO VERTEX WEIGHTS



TRACE STEP DETAILS

- REALLY SIMPLE HASH-GRID
 - FAST BUILD
 - SHORT RAYS -> FAST SEARCH
- READS ALPHA MASK
 - PREPROCESSED FOR ALL MESH-TEXTURE PAIRS



ALGORITHM INTEGRATION

- EXECUTED IN A SEPARATE THREAD
 - BACKGROUND TASK
 - TRIGGERED ON ITEM EQUIP
- USES BIND “T” POSE
- RESULTS CAN BE CACHED



ALGORITHM EXTENSIONS

- SMOOTHING WEIGHTS
 - APPLY KERNEL ON VERTEX-EDGE GRAPH



RESULTS - HAIR



RESULTS - HAIR



RESULTS - HAIR



RESULTS - HAIR

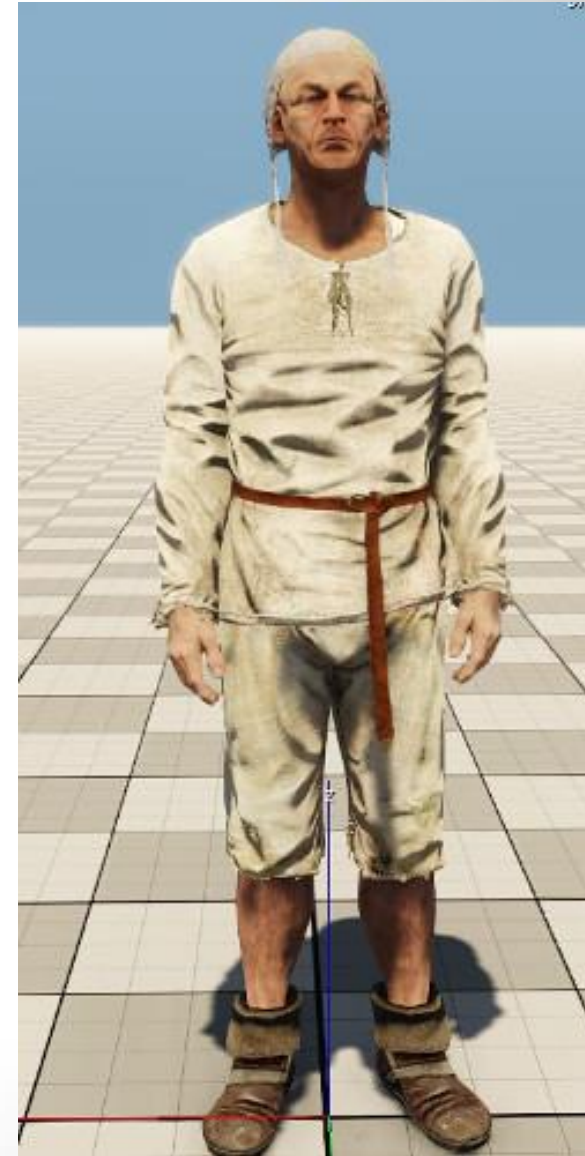


NOT LIMITED TO HUMANOIDS



PERFORMANCE

- I7-4770 @ 3.4 GHZ
- SIMPLE SETUP
 - BODY, CLOTH
 - 207,312 RAYS
 - 110 MS
 - 1.88 MRAYS/S



PERFORMANCE

- i7-4770 @ 3.4 GHZ
- ADVANCED SETUP
 - BODY, CLOTH, CHAIN
 - 417,400 RAYS
 - 365 MS
 - 1.14 MRAYS/S



PERFORMANCE

- I7-4770 @ 3.4 GHZ
- FULL SETUP
 - BODY, CLOTH, CHAIN, PLATE, DECO
 - 770,028 RAYS
 - 879 MS
 - 0.88 MRAYS/S



CONCLUSION



DRAWBACKS AND FUTURE WORK

- DISPLACEMENT MAPS
- ONLY LAYERED SHAPES SUPPORTED
- DRAW CALL FOR EVERY PIECE OF CLOTHING
 - FLAW OF THE WHOLE EQUIPMENT SYSTEM
- NOT INSTANT
 - CORRECT SHAPE APPEARS AFTER A FRACTION OF SECOND
- FURTHER OPTIMIZATIONS
 - EXPLORE BVHS -> CREATE OFFLINE, REFIT ONLINE





Meet us at Gamescom in **Hall 2.1** or **Hall 10.1** and try it yourself!